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3. Full name, address and postcode of the or of each applicant *(underline all surnames)*

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Patents ADP number *(if you know it)* 8344749002

If the applicant is a corporate body, give the country/state of its incorporation — United Kingdom

4. Title of the invention — A FLUID FILTRATION SYSTEM AND METHOD OF FILTERING FLUID

5. Name of your agent *(if you have one)* — BOULT WADE TENNANT

"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*

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Patents ADP number *(if you know it)* — 42001

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12. Name and daytime telephone number of person to contact in the United Kingdom

Trevor Thompson
020-7430-7500

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A FLUID FILTRATION SYSTEM AND METHOD OF FILTERING FLUID

The present application relates to a filtration system for filtering particulates and other matter from a fluid. The application further relates to a method of filtering particulates and other matter from a fluid.

It is known from PCT/AU96/00295 to provide a cylindrical mesh filter inside a chamber having an inlet port and an outlet port. The water to be filtered is introduced through the inlet port and passes through the filter before exiting through the outlet port. The particulates filtered from the water are trapped on the exterior surface of the mesh. The system is flushed by simultaneously injecting filtered water into the inlet port and opening a drain port while the filter is pressurised. A rotatable member is provided inside the cylindrical filter to spray filtered water onto the interior surface of the cylindrical mesh to dislodge filtered particulates trapped therein.

Filtration systems of the above type typically have a pump located upstream of the filter for supplying the liquid to the filter. However, as the liquid passes through the pump any particulates or other subject matter suspended in the liquid tend to be macerated by the pump. Therefore, the size of the particulates to be filtered is reduced and the size of the mesh required to filter the particles must be reduced accordingly. Moreover, the smaller the particulates suspended in the liquid the longer they take to settle. Thus, the efficiency of the system may be reduced.

A further disadvantage of filtration systems of the above type is that they generally require separate supply and purging pumps which increases the purchase and running costs of the apparatus.

Viewed from a first aspect the present invention provides a filtration system for filtering particulates from a liquid, the system comprising a sealed vessel suitable for supporting a pressure less than atmospheric pressure, and a first filter for filtering particulates from said liquid. The provision of a sealed vessel advantageously allows liquid to be drawn through the system.

In use, air may come out of suspension in the liquid, for example due to the changes of pressure in the system, and this may collect and form air pockets which prevent the operation of the system. An air evacuation means suitable for evacuating air from the system is preferably provided to ameliorate these problems. The air evacuation means advantageously helps prevent pockets of air forming in the filtration system. For example, the air evacuation means may prevent an air pocket forming in the sealed vessel. The air evacuation means may be an air pump. Preferably, however, the air evacuation means is a venturi. Preferably the venturi is provided on the pressure side of a pump.

Alternatively, the air evacuation means may be a tube or conduit connected to the inlet side of the pump. When the pump is operating, the pressure on the inlet side is reduced and this may draw air into the fluid flow into the pump.

The sealed vessel preferably defines a first chamber inside of which is provided the first filter. The first chamber is preferably maintained at least substantially full of liquid when the filtration system is operating.

A pump is preferably provided for reducing the pressure in the sealed vessel to draw liquid to be filtered into the vessel. The pump preferably draws filtered liquid out of the sealed vessel to cause said reduction in pressure. Preferably, the filtered liquid then passes through the pump and may be pumped to the system outlet. Preferably, in normal operation, the volume of liquid drawn into the sealed vessel to be filtered is substantially the same as the volume of filtered liquid drawn out of the sealed vessel by the pump.

A valve sub-system is preferably provided to allow the system to be changed between a filtration mode and a purging mode. The valve sub-system preferably changes the connection of the pump to the sealed vessel to change between the filtration and purging operational modes.

In the purging mode, the pump is preferably connected upstream of the sealed vessel. The pump preferably introduces a purging liquid into the sealed vessel to flush filtered particulates through a discharge outlet. The purging liquid is preferably introduced into the sealed vessel so as to reverse the direction of flow of the liquid through the first filter (relative to the flow direction when the system is operating in the filtration mode) so as to purge the filter. The valve sub-system is preferably operable to open the discharge outlet when the system is operating in the purging mode. Similarly, the valve sub-system is preferably operable to close the inlet into the sealed vessel when the system is operating in the purging mode.

The purging liquid may be liquid which has been filtered through the first filter provided in the first chamber and then stored in a suitable reservoir.

Alternatively, the purging liquid may be taken from a dedicated source, such as a mains water supply. Most preferably, however, the purging liquid is drawn from the supply of liquid to be filtered to avoid the need for a reservoir or a dedicated supply. A second filter may be provided to filter the purging liquid prior to its introduction into the sealed vessel.

In the filtration mode, the pump is preferably connected downstream of the first filter so as to draw liquid through the first filter. This arrangement advantageously allows a single pump to draw liquid from a plurality of sources, such as different conduits placed around a pond or other body of water. The liquid is preferably drawn into the sealed vessel through a system inlet connected to at least one conduit having at least one opening therein. In use, each of opening in the at least one conduit is preferably submerged in the liquid to be filtered to help prevent air being drawn into the filtration system.

The liquid is preferably drawn into the sealed vessel in a tangential direction so as to establish a rotational flow inside the sealed vessel. This rotational flow may advantageously draw particulates towards the centre of the vessel to allow more efficient filtration and/or collection.

The filtration system preferably further comprises a biological filter. The biological filter preferably comprises bio-media. When the system is operating in the filtration mode, at least some of the mechanically filtered liquid from the first chamber is preferably pumped to a second chamber in which the biological filter is provided. Preferably the second chamber is annular in cross-sectional shape and extends circumferentially around the first

chamber. Of course, the second chamber may be separate from the first chamber and connected thereto by one or more conduits.

In known filtration systems, bio-media is agitated by injecting a gas into the liquid in which the media is provided. However, the inventors in the present case have recognised that the liquid to be biologically filtered may be introduced in such a way as to agitate the bio-media and thereby reduce or remove the need to introduce gas for this purpose. The recognition of this possibility is considered to be independently patentable. Preferably, the liquid to be biologically filtered is introduced into the second chamber so as to induce a rotational flow of the liquid in that chamber and thereby to agitate the bio-media.

A third mechanical filter may be provided downstream of the first filter to perform an additional filtration step to remove particulates which have passed through the first filter. The third filter may, for example, be a foam member through which the liquid passes.

A UV light module may be provided to perform a final cleaning operation on the liquid before it is expelled from the filtration system.

The filtration system preferably also comprises a filter cleaning apparatus operable during the filtration mode. In the filtration mode, the cleaning apparatus preferably projects a cleaning liquid onto a downstream side of the first filter to dislodge particulates trapped on an upstream side thereof. The cleaning liquid is preferably liquid taken from downstream of the first filter, i.e. liquid which has already been mechanically filtered at least once. Although a separate dedicated pump may be provided to pump the cleaning liquid into the cleaning apparatus, the

cleaning liquid is preferably pumped to the cleaning apparatus by the pump which draws liquid though the first filter. Of course, the cleaning liquid may be supplied from any other suitable source, for example a mains water supply.

The cleaning apparatus may be fixed and the filter arranged to move relative thereto, but preferably the filter is fixed and the cleaning apparatus is movable. The cleaning apparatus preferably comprises a rotatable member having at least one outlet for projecting said cleaning liquid onto the downstream surface of the filter. The rotatable member is preferably rotatably mounted on a tubular member having at least one side-opening in liquid communication with an interior of the rotatable member.

The tubular member preferably has a closure member provided for directing liquid introduced into the tubular member through the at least one side-opening. The closure member is preferably generally frusto-conical in shape so as to efficiently direct the liquid in a radially outward direction. The closure member more preferably is frusto-conical in shape having a concave outer surface. The closure member may be fixedly attached to, or integrally formed with, the tubular member.

The supply of cleaning liquid to the cleaning apparatus is preferably controlled by the valve sub-system. In certain preferred embodiments, cleaning liquid is only supplied to the cleaning apparatus when the system is operating in the filtration mode.

A flow compensating device is preferably provided to increase the proportion of the cleaning liquid directed to the filter cleaning apparatus if the filter becomes partially blocked. The flow compensating device is preferably a spring-loaded valve and is preferably located

downstream of an inlet into the cleaning apparatus. The spring-loaded valve is preferably maintained in a fully open position when the flow rate of filtered liquid is sufficient to overcome the force of the spring. When the flow rate of the filtered liquid falls, for example because the filter is partially blocked, the spring preferably biases the valve towards its closed position thereby reducing the proportion of filtered liquid which may pass the flow compensating device and increasing the proportion directed to the inlet for the cleaning apparatus. The spring-loaded valve may be disc-shaped. Preferably, however, the valve has a conical portion which cooperates with a conical portion defined in an inside wall of a conduit in which the valve is located.

In the purging mode, the purging liquid is preferably introduced into the sealed vessel through the cleaning apparatus. Thus, liquid preferably passes through the first filter in opposite directions in the purging and filtration modes. The purging liquid dislodges particulates from the filter and these are displaced through the sealed vessel's discharge outlet, together with the purging liquid, and expelled from the filtration system.

If a flow compensating device is provided, this may be closed during the purging mode. Preferably, the valve sub-system closes the flow compensating device during the purging mode.

The first filter is preferably a cylindrical mesh and defines a third chamber in the filtration system. The cleaning apparatus is preferably located inside said mesh and is rotatable about the central axis of the cylinder. The mesh is most preferably in the form of a right cylinder.

The filter is preferably provided in an upper portion of the first chamber to facilitate, in use, the settling of

particulates filtered from the liquid supply in a lower portion of the first chamber. At least one baffle plate is preferably provided between the upper and lower portions of the first chamber to reduce the movement of the liquid in the lower portion of the first chamber. The baffle plate is preferably hollow frusto-conical in shape. The pump and the discharge outlet are preferably located in the lower portion of the first chamber.

A settling chamber may be provided in the first chamber to collect particulates suspended in the water. These particulates are generally small in size and sink only slowly to the bottom of the first chamber and tend to be drawn towards the centre of the first chamber by the rotation of the water therein. The collection device is preferably provided in the lower portion of the first chamber beneath the filter and also the at least one baffle plate (if fitted). The settling chamber is preferably defined by a cylindrical member which is open at its upper end. The settling chamber is preferably provided with an outlet though which particulates may be discharged. The outlet may be controlled by the valve sub-system. The settling chamber is preferably arranged co-axially with the tubular member which supports the rotatable member. The settling chamber is preferably purged when the system operates in its purging mode.

The system preferably comprises a pressure relief valve operable to prevent the pressure in the sealed vessel falling below a predetermined level. The pressure relief valve is preferably operable to place an inlet and an outlet of the pump in communication with each other to prevent further reduction in the pressure in the sealed vessel whilst allowing the pump to continue to operate. A spring

valve provided in the pressure relief valve preferably determines the pressure at which the relief valve operates.

The valve sub-system may be operated automatically, for example in response to a timer or a pressure switch, to change the operational mode of the filtration system. Preferably, however, the valve sub-system is manually operated.

Liquid is preferably pumped through the pump in the same direction when the system is operating in the filtration and purging modes.

The liquid to be filtered preferably enters the first chamber in a tangential direction to create a rotational flow in the region of the filter. A rotational flow tends to establish a flow pattern which improves the efficiency of the system.

The present invention further relates to a method of operating a filtration system to filter particulates from a liquid, the method including a filtration step and a purging step; the filtration step comprising reducing the pressure in a sealed vessel below atmospheric pressure to cause liquid to be filtered to be drawn into the sealed vessel, and passing the liquid through a filter; the purging step comprising introducing a purging liquid into the sealed vessel to expel particulates filtered from the liquid supply through a discharge outlet.

The method preferably comprises reducing the pressure in the sealed vessel by operating a pump to draw liquid out of the sealed vessel. The liquid is preferably drawn through the system and passes through the filter causing particulates to be mechanically filtered. The purging liquid may be taken from any suitable supply, such as a mains water supply or a reservoir of filtered liquid.

Preferably, however, the purging liquid is taken from the supply of liquid to be filtered.

Preferably, the same pumps draws liquid through the system in the filtration mode as displaces the purging liquid through the system in the purging mode. A changeover valve is preferably provided to change between said filtration and purging operational modes.

Viewed from a further aspect the present application relates to a filter cleaning apparatus comprising a rotatably mounted member having at least one outlet for projecting cleaning liquid onto a surface of a filter, the rotatable member having a channel connecting at least one inlet aperture to said at least one outlet, the rotatable member being mounted on a tubular member having at least one side-opening therein, the at least one side-opening being in liquid communication with said at least one inlet provided in the rotatable member.

Providing at least one side-opening in the tubular member advantageously results in the liquid supplied to the rotatable member travelling in a radial direction. The resulting axial forces on the rotatable member, and consequently the loads between the rotatable member and the tubular member, may be significantly reduced. Frictional forces acting on the rotational member may also be reduced.

Preferably, fluid is allowed also to escape at the junction between the rotatable member and the tubular member on which it is mounted. This additional flow of fluid advantageously maintains the bearing surfaces substantially free of particulates. Indeed, the flow of liquid around the base of the rotatable member may support the rotatable member and further reduce frictional forces and also reduce wear on the components as they rotate. A gap of, for

example, 1mm or less may be provided between the rotatable member and the tubular member.

The rotatable member preferably has a central collar portion extending around the tubular member. The at least one inlet aperture is preferably provided on the inside of said collar. The at least one inlet aperture preferably extends substantially around the circumference of the tubular member. More preferably the collar is at least partially open to the interior thereof to define said at least one inlet aperture. This arrangement advantageously ensures that liquid communication between said at least one outlet and said at least one inlet aperture is maintained irrespective of the angular orientation of the rotatable member.

First and second annular projections are preferably provided on the outer surface of the tubular member to locate axially the rotatable member. A closure member is preferably provided to direct liquid introduced into the tubular member radially outwardly into the at least one inlet aperture in the rotatable member. The closure member is preferably frusto-conical in shape.

The features of the cleaning apparatus may readily be utilised as part of the filtration system described elsewhere in the present application.

Viewed from a still further aspect, the present application relates to a filtration system comprising a chamber housing a biological filter media, wherein liquid to be biologically filtered is introduced into the chamber through an inlet, and said inlet is arranged such that, in use, the liquid agitates the filter media. The chamber housing the biological filter is preferably annular in

cross-section and more preferably extends circumferentially around a central chamber housing a mechanical filter.

Viewed from a yet still further aspect, the present application relates to a filtration system for filtering liquid from a body of liquid, the system comprising a filter and a pump, the filter being provided on the suction side of the pump when the system is operating in a filtration mode; wherein the system is adapted to allow liquid from the body of liquid to be filtered when the system is located above the level of the liquid in said body of liquid. Advantageously, therefore, the system need not be located below the level of the body of liquid (as is the case in the prior art systems) and may draw liquid through the filter before it passes through the pump. The particulate matter in the water may, therefore, be filtered before the liquid passes through the pump. The filtration system is preferably self priming to help facilitate the desired functionality. The system may be provided with a venturi.

Viewed from a still further aspect the present invention provides a filtration system for filtering particulates from a liquid supply, the system being operable in a filtration mode and a purging mode, the system comprising a first chamber, a filter, a pump and a valve sub-system, the filter being provided in said first chamber; wherein, when the system is operating in the filtration mode, the pump is connected downstream of the first chamber and draws liquid through the filter; and, when the system is operating in the purging mode, the pump is connected upstream of the first chamber and pumps a purging liquid into the first chamber to flush filtered particulates through a discharge outlet; the valve sub-system being operable to change the connection of the pump to the first

chamber and thereby to change the operational mode of the system.

The present invention further relates to a method of operating a filtration system to filter particulates from a liquid supply, the method comprising a filtration step and a purging step; the filtration step comprising passing the liquid supply through a filter provided in a first chamber and pumping the filtered liquid through an outlet; the purging step comprising pumping a purging liquid into the first chamber to expel particulates filtered from the liquid supply through a discharge outlet; wherein the pumping of the filtered liquid and of the purging liquid is performed by the same pump and a changeover valve is operated to change the pump connections to the first chamber.

Viewed from a yet still further aspect, the present invention relates to a vessel for use in a filtration system, the vessel comprising a collection chamber for collecting particulates filtered from a fluid, wherein a settling chamber is provided in said collection chamber. The fluid to be filtered is preferably introduced into the collection chamber in a tangential direction to establish a rotational flow in the collection chamber. Advantageously, the rotational movement draws small particulates suspended in the fluid towards the centre of the collection chamber. The settling chamber is preferably provided in the centre of the collection chamber so that particulates may be drawn into it by the rotational flow of the fluid in the collection chamber. A rotational flow of the fluid to be filtered may also cause larger particulates in the fluid to be displaced to the outside of the collection chamber. In use, the movement of fluid in the settling chamber is

reduced and suspended particulates are caused to settle more quickly.

A filter is preferably provided in said collection chamber. The settling chamber is preferably provided below said filter.

A first discharge outlet is preferably provided to facilitate expulsion of the filtered particulates from the collection chamber. A second discharge outlet is preferably provided to facilitate expulsion of the filtered particulates from the settling chamber.

The settling chamber is preferably defined by a cylindrical sidewall and is preferably open at its upper end. A baffle plate is preferably provided in the collection chamber. The baffle plate is preferably hollow frusto conical in shape.

The present application further relates to a filtration system comprising a vessel as described herein.

Preferred embodiments of the present invention will now be described, by way of example only, and with reference to the accompanying drawings, in which:

Figure 1 shows a partial cross-sectional view of a liquid filtration system in accordance with the present invention;

Figure 2 shows a plan view of the filtration system;

Figure 3 shows an enlarged view of the rotatable cleaning member of the filtration system shown in Figure 1;

Figure 4 shows a cross-section along line AC-AC of the filtration system shown in Figure 2;

Figure 5 shows a perspective view of a pressure relief valve for use in the filtration system of the present invention;

Figure 6 shows a cross-section through the pressure relief valve shown in Figure 5;

Figure 7 shows schematically the filtration system operating in a filtration mode;

Figure 8 shows schematically the filtration system operating in a purging mode;

Figure 9 shows schematically a second embodiment of the filtration system operating in a filtration mode; and

Figure 10 shows schematically the embodiment of the filtration system shown in Figure 9 operating in a purging mode.

A liquid filtration system 1 for filtering water from a body of water, such as a pond, in accordance with the present invention is shown in Figure 1. The filtration system 1 comprises a housing 2, a central chamber 3 and an outer annular chamber 5. The housing 2 is sealed so as to allow a pressure less than atmospheric pressure to be sustained in the central chamber 3 and the outer chamber 5. The filtration system 1 is operable in a filtration mode and a purging mode and a change-over valve system 7 is provided to change between these modes. A plan view of the filtration system 1 is shown in Figure 2.

The central chamber 3 is circular in cross-section and houses a mechanical filter assembly 9. A discharge outlet 11 is provided in the base of the central chamber 3. The annular chamber 5 is provided around the circumference of the central chamber 3 and houses a biological filter 12, such as the bio-mass supplied by Kaldnes Miljøteknologi AS, Norway. A foam filter 13 is provided to perform an additional filtration step before the filtered water passes through an ultra-violet light module 14.

A circulating pump 15 is provided having an inlet 16 and an outlet 17. The pump 15 draws water into the system 1 through a system inlet port 18. The water may be drawn through a conduit (not shown) connected to the system inlet 18 and having a plurality of inlet apertures open to the body of water to be filtered. Providing a plurality of inlet apertures advantageously allows water to be drawn from different locations which may, for example, be distributed around the body of water. The filtered water is expelled from the filtration system 1 through a system outlet port 20 back into the body of water.

The mechanical filter 9 comprises a cylindrical mesh 19 supported by frame members 21. The mesh defines a filter chamber 23 inside the central chamber 3. Filtered water exits the filter chamber 23 through a filter outlet (not shown). The mesh 19 for the filter 9 may be made from any suitable metal or plastics material. Although the flexing of a plastic mesh helps to prevent bacteria growing on the mesh, Microban (RTM) may be added to the plastics material from which the mesh is made, or applied to the surface of the mesh, to limit microbial action.

As most clearly shown in Figure 3, a rotatable member 25 is provided inside the filter chamber 23 for cleaning the mesh 19. The rotatable member 25 is mounted on a tubular pillar 27 provided in the central chamber 3. The pillar 27 extends downwardly through the base of the central chamber 3 and is connected to the change-over valve system 7, as shown in Figure 4. A pair of annular projections 29, 31 are provided on the outside of the pillar 15 to locate axially the rotatable member 25.

The rotatable member 25 comprises first and second radially extending fan-shaped members 33; 35 and a shaft

portion 36. The radially outermost edges of the fan-shaped members 33, 35 each extend substantially parallel to the inside surface of the cylindrical mesh 19 and each have an outlet 37, 39 defined therein. The outlets 37, 39 are substantially the same axial length as the filter mesh 19 and are inclined at an angle of approximately 20° to a radial direction extending through the axis of rotation of the member 25. The shaft portion 36 helps locate the rotatable member 25 and ensure axial rotation about the pillar 27.

The rotatable member 25 has a central collar 41 extending circumferentially around the pillar 27. The interior of the collar 41 is open to the outside of the pillar 27 about its circumference. A channel is formed in each of the fan-shaped members 33, 35 connecting the open interior of the collar 41 to the outlets 37, 39. The collar 41 is arranged such that the channels in the fan-shaped members 33, 35 extend around the circumference of the pillar 27.

A plurality of side-openings 43 are provided in the pillar 27 between the annular projections 29, 31 which locate the rotatable member 25. As the collar 41 is open to its interior and extends around the circumference of the pillar 27, the channels in the fan-shaped members 33, 35 remain in fluid communication with the interior of the pillar (via the side-openings 43) irrespective of the angular orientation of the rotatable member 25. A closure member 44 having a frusto-conical shape is provided in the pillar 27 to close the upper end thereof and also to direct liquid radially outwardly through the side-openings 43.

A first hollow frusto-conical baffle plate 45 is provided around the outer, lower edge of the filter 19. A

second hollow frusto-conical baffle plate may also be provided inwardly of the first baffle plate 45 around the central pillar 27. The baffle plate 45 divides the central chamber 3 into upper and lower portions.

The mechanical filter 9 is provided in the upper portion of the central chamber 3 and the pump 15 is provided in the lower portion thereof. To facilitate servicing of the pump 15, the housing 2 has a removable cover 49 and the mechanical filter 9 is removable as a unit. An O-ring 50 is provided to create a seal between the housing 2 and the cover 49.

A system priming inlet 51 is provided in the housing 2 to facilitate the introduction of water into the central chamber 3 to prime the pump 15 ready for use. A screw cap 53 is provided sealingly to close the priming inlet 49 during normal operation of the filtration system 1.

A settling chamber 55 is provided in the central chamber 3 beneath the mechanical filter 9. The settling chamber has a cylindrical sidewall and is closed at its lower end. The settling chamber 55 is open at its upper end and this opening is partially shielded by the baffle plate 45 further to reduce the velocity of the water entering the settling chamber. Thus, small particulates suspended in the water in the settling chamber 55 settle relatively quickly. A second discharge outlet 57 is provided at the bottom of the settling chamber to allow the filtered particulates collected therein to be expelled when the filtration system 1 is purged.

As shown in Figures 5 and 6, a pressure relief valve 59 is provided to prevent the pressure in the housing 1 falling below a predetermined safety level, for example, if the system inlet port 18 becomes blocked. The pressure relief

valve 59 has a first inlet 61 in fluid communication with the pump inlet 16 and a second inlet 63 in fluid communication with the pump outlet 17. A diaphragm 65 is provided in the pressure relief valve 59. If the suction head across the pump 15 exceeds the predetermined level, the diaphragm 65 is displaced and a gate valve 67 is opened to bring the pump inlet 16 and the pump outlet 17 into fluid communication with each other. Thus, further reduction of the pressure in the housing 1 is prevented whilst the pump 15 is allowed to continue to operate. The output flow from the pump 15 is reduced when the gate valve 67 is open but it is generally still sufficient to provide cleaning water to the rotatable member 25 to clear the mechanical filter 9 and allow the filtration system 1 to return to normal operation. A spring 69 biases the diaphragm 65 and the gate valve 67 to their closed positions.

In use, air comes out of suspension in the water as it passes through the filtration system 1 or it may enter through leaks at joints between components. If air is allowed to collect it is necessary periodically to top-up the water levels in the filtration system 1. To help reduce the amount of air which collects, a venturi 71 is provided on the outlet side of the pump 15 and a suction tube 73 is connected to a throat section thereof. The venturi 71 provides a suction force which draws air through the suction tube 73 and into the stream of liquid on the outlet side of the pump 15. The air is then expelled from the filtration system 1 with the filtered water. The tube 73 is preferably connected at one end to the venturi 71 on the outlet side of the pump 15 and at the other end to the top of the central chamber 3 to ensure that a pocket of air does not form which may prevent the system 1 from operating.

As shown in Figure 4, a flow compensating device 75 is provided in a conduit 79 between the inlet for the rotatable member 25 and the foam filter 13. The flow compensating device 75 comprises a spring-loaded conical valve member 77 (shown in its open position) which cooperates with a conical portion 81 of the conduit 79 to close the flow compensating device. A spring (not shown) biases the conical valve member 77 towards its closed position but in normal operation the flow of filtered water through the conduit 79 displaces the valve member towards its open position. A reduction in the flow of liquid through the system 1 (for example as a result of the mesh 19 becoming blocked) allows the spring to bias the conical valve member 77 towards a closed position and, thereby, to reduce the proportion of the flow directed to the foam filter 13 (and system outlet 20) and increase the proportion being directed to the rotatable member 25. The flow compensating device may advantageously operate in conjunction with the pressure relief valve 59 to direct flow to the rotatable member 25 when the gate valve 69 is open and the output from the pump 15 is reduced.

As outlined above, the filtration system 1 may operate in a filtration mode or a purging mode. The mode of operation is determined by the change-over valve system 7 and is selected by manually rotating a handle 81. The change-over valve system 7 comprises an inlet valve 83 for controlling the supply of fluid into the central chamber 3; a debris discharge valve 85 for controlling the discharge of filtered particulates from the system 1; a first filtrate control valve 87 for controlling the flow of filtrate from the annular chamber 5 to the pump 15; and a second filtrate

control valve 89 for controlling the flow of filtrate from the pump 15 to the foam filter and the UV module.

The change-over valve system 7 also comprises an inlet filter 91. The inlet filter 91 is by-passed when the inlet valve 83 and the first filtrate control valve 87 are open. Conversely, when the inlet valve 83 and the first filtrate control valve 87 are shut, the inlet flow is directed through the inlet filter.

The operation of the filtration system 1 in the filtration and purging modes will now be described with reference to Figures 7 and 8. The valves 83, 85, 87, 89 in the change-over valve system 7 are represented schematically in Figures 7 and 8 with a dashed line when they are in they are in their open positions, and with a solid line when they are in their shut positions. The direction of the liquid flow through the system 1 is represented by arrows.

When the filtration system 1 is operating in its filtration mode, the inlet valve 83, and the first and second filtrate control valves 87, 89 are open. The debris discharge valve 85 is shut. The pump 15 draws water from the annular chamber 5 and this in turn draws water from the filter chamber 23 into the annular chamber via a conduit (not shown). The pressure in the filter chamber 23 is thereby reduced and water is drawn into the central chamber 3 through the system inlet 18; the inlet filter 91 is by-passed. The system inlet 18 is arranged such that the water is drawn into the central chamber 3 in a tangential direction so as to establish a rotational flow in the central chamber.

The water enters the central chamber 3 and is drawn through the mesh 19. Particulates suspended in the water drawn into the filter chamber 23 are trapped on the outside

surface of the mesh 19 and the water entering the filter chamber is mechanically filtered.

The mechanically filtered water is drawn into the annular chamber 5 where it is biologically filtered. Preferably, the mechanically filtered liquid is introduced into the annular chamber 5 tangentially to induce a rotational motion to agitate the bio-media in the biological filter.

The biologically filtered water then enters the pump inlet 16, via the valve change-over system 7, and is pumped through the venturi 71. The pressure is reduced in the throat of the venturi 71 and air is drawn through the suction tube 73 into the water stream.

A proportion of the water downstream of the pump 15 is then directed into the pillar 27. The liquid exits the pillar 27 through the at least one outlet aperture 43 and enters the channels provided in the fan-shaped members 33, 35. The liquid is then expelled through the outlets 37, 39 and impinges on the inner surface of the mesh 19 to dislodge particulates or other matter trapped in the outer surface thereof. The angular inclination of the outlets 37, 39 causes the member 25 to rotate so that the outlets traverse substantially all of the inside surface of the mesh 19.

The particulates dislodged from the outer surface of the mesh 19 sink to the bottom of the central chamber 3. The hollow frusto-conical baffle plate 45 reduces the velocity of the liquid in the lower portion of the central chamber 3 and this reduces the liquid's ability to transport particulates. Thus, the particulates settle on the base of the chamber central 3 relatively quickly.

The proportion of the water introduced into the rotatable member 25 is determined by the flow compensating

device 75. If the flow from the pump 15 is reduced because the mesh 19 is partially blocked, the conical valve member 77 will be biased towards its closed position and the proportion of the flow directed to the rotatable member 25 increased to help clean the mesh 19.

The continued action of the pump 15 pumps the liquid to the foam filter 13 and then through the UV light module 14. The filtered water is returned to the body of water via the system outlet 20. An outlet conduit (not shown) is connected to the system outlet 20 to deliver the filtered water to the desired location. The outlet conduit may have a plurality of openings to discharge the filtered water in different locations.

When the filtration system 1 is operating in the purging mode, the inlet valve 83, and the first and second filtrate valves 87, 89 are shut. The debris discharge valve 85 is open. The liquid supply for the system 1 is fed to the pump inlet 16 via the inlet filter 91. The pump 15 pumps the liquid into the central chamber 3 via the rotatable member 25. The purging liquid washes the mesh 19 and displaces any particulates trapped therein into the central chamber 3. The purging liquid and the filtered particulates are then discharged from the central chamber 3 through the first discharge outlet 11. The purging liquid also discharges particulates collected in the settling chamber 55 through the second discharge outlet 57. The debris is expelled from the system 1 through the open debris discharge valve 85.

The purging operation is preferably performed periodically for 10 to 15 seconds. During the purging mode, the pressure in the central chamber 3 may be greater than

atmospheric pressure to assist in the expulsion of the accumulated particulates.

The inlet filter 91 is readily accessible to facilitate manual cleaning as required.

The arrangement of the present invention whereby the pump 15 draws the liquid to be filtered through the mesh 19 in the filtration mode is particularly advantageous as it prevents the particulates suspended in the liquid from being macerated by the pump prior to filtration. In known systems, where the liquid to be filtered passes through the pump before reaching a mechanical filter, the particulates are typically much smaller as a result of the action of the pump and, therefore, a finer filter mesh is required. Moreover, the drawing action of the pump advantageously allows liquid to be drawn into the filtration system 1 from a plurality of locations, for example, using a Y-shaped inlet tube.

A second embodiment of the present invention is shown schematically in Figures 9 and 10. The second embodiment is similar to the first embodiment described above and like reference numerals have been used for like components. The second embodiment is not, however, provided with a foam filter 13.

The operation of the filtration system 1 according to the second embodiment will now be described with reference to Figures 9 and 10 in which the change-over valve system 7 is shown schematically with the blacked-out regions illustrating a closed valve.

When the filtration system 1 according to the second embodiment is operating in a filtration mode, water is drawn into the system 1 through the system inlet 18 by the pump 15, as shown in Figure 9. The water enters the central

chamber 3 and is drawn through the mesh 19 into the filter chamber 23 by the pump 15. Particulates suspended in the water drawn into the filter chamber are trapped on the outside surface of the mesh 19 and the water entering the filter chamber 23 is thereby mechanically filtered.

The pump 15 then draws the mechanically filtered water through the filter outlet and into the pump inlet 16 via the valve change-over system 7. The water is then pumped out of the pump outlet 17 and into the annular chamber 5 for biological filtration. Preferably, the mechanically filtered liquid is introduced into the annular chamber 5 tangentially to induce a rotational motion in the water in the annular chamber. The rotational motion of the water agitates the bio-media in the biological filter and may remove the need to inject gas into the biological filter to perform this function. The continued action of the pump 15 forces the biologically filtered liquid in the annular chamber 9 into the UV light module 14.

A proportion of the mechanically filtered water downstream of the pump 15 is pumped into the pillar 27. The liquid exits the pillar 27 through the at least one outlet aperture 43 and enters the channels provided in the fan-shaped members 33, 35. The liquid is then expelled through the outlets 37, 39 and impinges on the inner surface of the mesh 19 to dislodge any particulates or other matter trapped in the outer surface thereof. The angular inclination of the outlets 37, 39 causes the member 25 to rotate so that the outlets traverse substantially all of the inside surface of the mesh 19.

A portion of the filtered water introduced into the pillar 27 is allowed to escape between the shaft portion 36 and the annular projections 29, 31 in order to clean the

bearings on which the rotatable member 25 rotates. In practice, the rotatable member 25 may be supported by the water as it escapes under pressure and, in use, the rotatable member may effectively "float". This arrangement helps to ensure that the rotatable member 25 is balanced. The intentional release of water to clean the bearing is facilitated by providing a gap of 1mm between the shaft portion 36 and each of the annular projections 29, 31.

The particulates dislodged from the outer surface of the mesh 19 sink to the bottom of the central chamber 3. The hollow frusto-conical baffle plate 45 reduces the velocity of the liquid in the lower portion of the central chamber 3. The liquid's ability to transport particulates is thereby reduced and the particulates are caused to settle on the base of the chamber relatively quickly.

The filtered water is returned to the body of water via the system outlet 20. An outlet conduit (not shown) is connected to the system outlet 20 to deliver the filtered water to the desired location. The conduit may have a plurality of openings to discharge the filtered water in different locations.

When the filtration system 1 is operating in the purging mode, the liquid supply for the system 1 is fed directly to the inlet 16 of the pump 15, as shown in Figure 10. The pump 15 pumps the supply liquid into the central chamber 3 on the outside (i.e. upstream) of the cylindrical mesh 19, to expel the particulates which have settled on the base of the chamber through the first discharge outlet 11, and also to expel particulates collected in the settling chamber 55 through the second discharge outlet 57. During the purging mode, the pressure in the central chamber 3 may

be greater than atmospheric pressure to assist in the expulsion of the accumulated particulates.

The purging operation is preferably performed periodically for 10 to 15 seconds. The outlet from the annular chamber 5 housing the biological filter and/or the supply to the rotatable member 25 are preferably closed during the purging operation.

A flow compensating valve 75 is also provided between the change-over valve system 7 and the UV module 14. The operation of the flow compensating valve 75 in this embodiment is unchanged from the description outlined elsewhere herein.

The second embodiment described herein may also be provided with an inlet filter (not shown) for filtering particulates from the liquid to be supplied to the rotatable member 25.

The embodiments described herein are manually primed prior to use. However, the person skilled in the art will appreciate that the system may be self-priming. A self-priming system would initially draw air through the filtration system 1 which in turn would draw water through the system. A pump capable of drawing both air and water may be used to self-prime the system, but preferably a separate air pump is provided.

Although the change-over valve system 7 has been described as being manually operated, it will be appreciated that an automatic valve may be provided which responds, for example, to a programmable timer or a pressure switch.

The skilled person will also appreciate that a separate dedicated pump may be provided to supply liquid to the rotational member 25. The pump 15 may draw liquid directly from the filter chamber 23 or from the conduit connecting

the central chamber 3 with the annular chamber 5. Indeed, a dedicated liquid supply from any source could be used.

Furthermore, rather than inclining the outlets 37, 39 of the fan-shaped members 33, 35 to effect rotation of the member 25, a separate mechanical drive may be provided. Indeed, the liquid may be introduced into the central chamber 3 tangentially to create a rotational movement which in turn may rotate one or more paddles which are drivingly connected to the rotatable member 25. The rotational motion of the liquid in the annular chamber 5 may equally be used to rotate paddles to drive the rotatable member 25.

It will also be appreciated that the pressure relief valve described herein could be modified to measure and/or react to the differential pressure across the mesh 19. This arrangement would facilitate improved mesh overload control. However, this arrangement would not afford the same level of protection for the sealed vessel against excessive pressure reduction if, for example, the pond inlet becomes blocked. A further relief valve may therefore be provided to limit the reduction of pressure in the sealed vessel which operated by introducing air into the vessel. Although the introduction of air into the system 1 would necessitate that it is re-primed, this is clearly preferable to damaging the sealed vessel or pump. Alternatively, the sealed vessel could be strengthened to ensure that the pump 15 could not reduce the pressure in the vessel sufficiently to cause it to collapse and only the differential across the mesh 19 would have to be controlled.

Although the system has been described herein with reference to filtering the water in a pond, it will be appreciated that it may be used to filter other liquids and

may also be used to filter water for irrigation, fisheries, hatcheries, swimming pools and baths.

CLAIMS:

1. A filtration system for filtering particulates from a liquid, the system comprising a sealed vessel suitable for supporting a pressure less than atmospheric pressure, and a filter for filtering particulates from said liquid.

2. A filtration system as claimed in claim 1, wherein a first chamber is defined in the sealed vessel and the filter is provided in said first chamber.

3. A filtration system as claimed in claim 1 or 2 further comprising air evacuation means suitable for evacuating air from the system.

4. A filtration system as claimed in claim 3, wherein the air evacuation means is arranged to evacuate air from the sealed vessel.

5. A filtration system as claimed in claim 3 or 4, wherein the air evacuation means is a venturi.

6. A filtration system as claimed in any preceding claim further comprising a pump suitable for reducing the pressure in said sealed vessel to cause liquid to be drawn into the vessel.

7. A filtration system as claimed in claims 5 and 6, wherein the venturi is connected on the pressure side of the pump.

8. A filtration system as claimed in claim 6 or 7 further comprising a valve sub-system operable to change the connection of the pump to the sealed vessel.

9. A filtration system as claimed in claim 8, wherein the valve sub-system is operable to connect the pump upstream of the sealed vessel to cause the system to operate in a purging mode.

10. A filtration system as claimed in claim 9, wherein, when the system is operating in said purging mode, the pump introduces a purging liquid into the sealed vessel to flush filtered particulates through a discharge outlet.

11. A filtration system as claimed in claim 10, wherein the valve sub-system is operable to open and/or close the discharge outlet.

12. A filtration system as claimed in claim 10 or 11, wherein the purging liquid is liquid taken from upstream of the filter.

13. A filtration system as claimed in any one of claims 8 to 12, wherein the valve sub-system is operable to connect the pump downstream of the sealed vessel to cause the system to operate in a filtration mode.

14. A filtration system as claimed in claim 13, wherein, when the system is operating in the filtration mode, the pump draws the liquid supply into the system through a system inlet, the system inlet being connected to at least one conduit having at least one opening.

15. A filtration system as claimed in any preceding claim, further comprising a biological filter.

16. A filtration system as claimed in claim 15, wherein said biological filter is provided in a second chamber having an annular cross-section and extending circumferentially around the sealed vessel.

17. A filtration system as claimed in claim 16, wherein biological filter comprises media and the inlet to the second chamber is arranged such that, when liquid is drawn into the second chamber, the media are agitated.

18. A filtration system as claimed in any preceding claim further comprising a UV light module.

19. A filtration system as claimed in any preceding claim further comprising a filter cleaning apparatus for projecting a cleaning liquid onto a downstream side of the filter to dislodge particulates trapped on an upstream side thereof.

20. A filtration system as claimed in claim 19 further comprising a flow compensating device for increasing the proportion of the cleaning liquid directed to the filter cleaning apparatus when the filter is partially blocked.

21. A filtration system as claimed in claim 20, wherein the flow compensating device is a spring-loaded valve.

22. A filtration system as claimed in claim 19, 20 or 21, wherein the cleaning liquid is liquid filtered by the filter.

23. A filtration system as claimed in any one of claims 19 to 22 when dependent directly or indirectly on claim 13, wherein the cleaning liquid is supplied to the filter cleaning apparatus only when the system is operating in a filtration mode.

24. A filtration system as claimed in claim 23, wherein the supply of cleaning liquid is controlled by the valve-subsystem.

25. A filtration system as claimed in any one of claims 19, 20 or 21 when dependent directly or indirectly on claim 10, wherein the purging liquid is introduced into the sealed vessel through said filter cleaning apparatus when the system operates in said purging mode.

26. A filtration system as claimed in any one of claims 19 to 25 when dependent directly or indirectly on claim 6, wherein the cleaning liquid is supplied to the filter cleaning apparatus by the pump.

27. A filtration system as claimed in any one of claims 19 to 25, wherein the cleaning liquid is supplied to the filter cleaning apparatus by a separate dedicated pump.

28. A filtration system as claimed in any one of claims 19 to 27, wherein the cleaning apparatus comprises a rotatable

member having an outlet for projecting the cleaning liquid onto a surface of the filter.

29. A filtration system as claimed in claim 27 wherein the rotatable member is rotatably mounted on a tubular member having at least one side-opening for supplying cleaning liquid to said rotatable member.

30. A filtration system as claimed in claim 29 further comprising a closure member for closing an end of the tubular member and for re-directing liquid introduced into the tubular member through the at least one side-opening.

31. A filtration system as claimed in claim 29, wherein the closure member is generally frusto-conical in shape.

32. A filtration system as claimed in claim 30 or 31, wherein the closure member is fixedly attached to the tubular member.

33. A filtration system as claimed in claim 30 or 31, wherein the closure member is integrally formed with the tubular member.

34. A filtration system as claimed in any preceding claim wherein the filter is a cylindrical mesh defining a third chamber.

35. A filtration system as claimed in claim 34 wherein the filter is provided in said sealed vessel and the liquid supply is introduced into the sealed vessel to the outside of the cylindrical mesh.

36. A filtration system as claimed in any preceding claim wherein the filter is provided in an upper portion of the sealed vessel to facilitate, in use, the settling of particulates in a lower portion thereof.

37. A filtration system as claimed in claim 36, wherein at least one baffle plate is provided in the sealed vessel.

38. A filtration system as claimed in claim 37, wherein the at least one baffle plate is hollow frusto-conical in shape.

39. A filtration system as claimed in any one of claims 36, 37 or 38, wherein a settling chamber is defined in a lower portion of the sealed vessel.

40. A filtration system as claimed in claim 39, wherein the settling chamber is provided beneath the filter.

41. A filtration system as claimed in claim 39 or 40, wherein the settling chamber is defined by a cylindrical member open at its upper end.

42. A filtration system as claimed in claim 39, 40 or 41, wherein the settling chamber is provided with an outlet for evacuating particulates.

43. A filtration system as claimed in any preceding claim further comprising a pressure relief valve.

44. A filtration system as claimed in claim 43 wherein the pressure relief valve is operable to prevent the pressure in the sealed vessel falling below a predetermined level.

45. A filtration system as claimed in claim 43 or 44 when dependent directly or indirectly on claim 6, wherein the pressure relief valve is operable to place an outlet of the pump in communication with an inlet of the pump when the pressure in the sealed vessel falls below said predetermined level.

46. A method of operating a filtration system to filter particulates from a liquid, the method including a filtration step and a purging step;

the filtration step comprising reducing the pressure in a sealed vessel below atmospheric pressure to cause liquid to be drawn into the sealed vessel, and passing liquid to be filtered through a filter;

the purging step comprising introducing a purging liquid into the sealed vessel to expel particulates filtered from the liquid through a discharge outlet.

47. A method as claimed in claim 46, wherein a pump reduces the pressure in the sealed vessel by drawing liquid out of the sealed vessel; and the purging liquid is introduced into the sealed vessel by the same pump.

48. A method as claimed in claim 47, wherein a changeover valve is operated to change the pump connections to the sealed vessel to change the operational mode of the filtration system.

49. A method as claimed in any one of claims 46, 47 or 48, wherein the purging liquid is liquid taken from the same source as the liquid to be filtered.

50. A filter cleaning apparatus comprising a rotatably mounted member having at least one outlet for projecting cleaning liquid onto a surface of a filter, the rotatable member having a channel connecting at least one inlet aperture to said at least one outlet, the rotatable member being mounted on a tubular member having at least one side-opening therein, the at least one side-opening being in liquid communication with said at least one inlet aperture.

51. A filter cleaning apparatus as claimed in claim 50, wherein the rotatable member comprises a central collar, said collar extending substantially around said tubular member and being at least partially open to the interior thereof to define said at least one inlet aperture.

52. A filter cleaning apparatus as claimed in claim 50 or 51, wherein first and second annular projections are provided on the outer surface of the tubular member to axially locate said rotatable member.

53. A filter cleaning apparatus as claimed in claim 50, 51 or 52, wherein a closure member is provided for directing liquid introduced into the tubular member radially outwardly into the at least one inlet aperture in the rotatable member.

54. A filter cleaning apparatus as claimed in claim 53, wherein the closure member is frusto-conical in shape.

55. A filtration system comprising a chamber housing a biological filter media, wherein liquid to be biologically filtered is introduced into the chamber through an inlet, and said inlet is arranged such that, in use, the liquid agitates the filter media.

56. A filtration system as claimed in claim 55, wherein the inlet is arranged such that, in use, the liquid is introduced into the chamber in a tangential direction for creating a rotational flow in said chamber.

57. A filtration system as claimed in claim 55 or 56, wherein the chamber is annular in cross-section.

58. A filtration system as claimed in claim 57, wherein the annular chamber extends circumferentially around a central chamber.

59. A filtration system as claimed in claim 58, wherein said central chamber houses a mechanical filter.

60. A filtration system for filtering water from a body of water, the system comprising a filter and a pump, the filter being provided on the suction side of the pump when the system is operating in a filtration mode; wherein the system is adapted to allow water from the body of water to be filtered when the system is located above the water level in the body of water.

61. A sealed vessel to be used in the filtration system of any one of claims 1 to 45.

62. A vessel for use in a filtration system, the vessel comprising a collection chamber for collecting particulates filtered from a fluid, wherein a settling chamber is provided in said collection chamber.

63. A vessel as claimed in claim 62 further comprising a first discharge outlet to facilitate expulsion of filtered particulates from the collection chamber and a second discharge outlet to facilitate expulsion of filtered particulates from the settling chamber.

64. A vessel as claimed in claim 62 or 63 wherein the settling chamber is defined by a cylindrical sidewall and is open at its upper end.

65. A vessel as claimed in claim 62, 63 or 64 further comprising a baffle plate.

66. A vessel as claimed in claim 65 wherein the baffle plate is hollow frusto conical in shape.

67. A filtration system comprising a vessel as claimed in any one of claims 62 to 66.

68. A filtration system as claimed in claim 67 further comprising a cylindrical filter.

69. A filtration system as claimed in claim 68 wherein the settling chamber is provided below the filter.

70. A filtration system as claimed in claim 69 wherein the settling chamber is cylindrical and the settling chamber and the filter are arranged co-axially.

71. A filtration system substantially as herein described with reference to Figures 1 to 8; or Figures 1 to 6, 9 and 10.

72. A vessel for use in a filtration system substantially as herein described with reference to Figures 1 to 8; or Figures 1 to 6, 9 and 10.

73. A filter cleaning apparatus substantially as herein described with reference to Figures 1 to 8; or Figures 1 to 6, 9 and 10.

ABSTRACT:

A LIQUID FILTRATION SYSTEM AND METHOD OF FILTERING LIQUID

The present invention relates to a filtration system (1) for filtering particulates from a liquid. The filtration system has a sealed vessel (2) suitable for supporting a pressure less than atmospheric pressure. A filter (9) is provided for filtering particulates from the liquid.

[Fig. 1]

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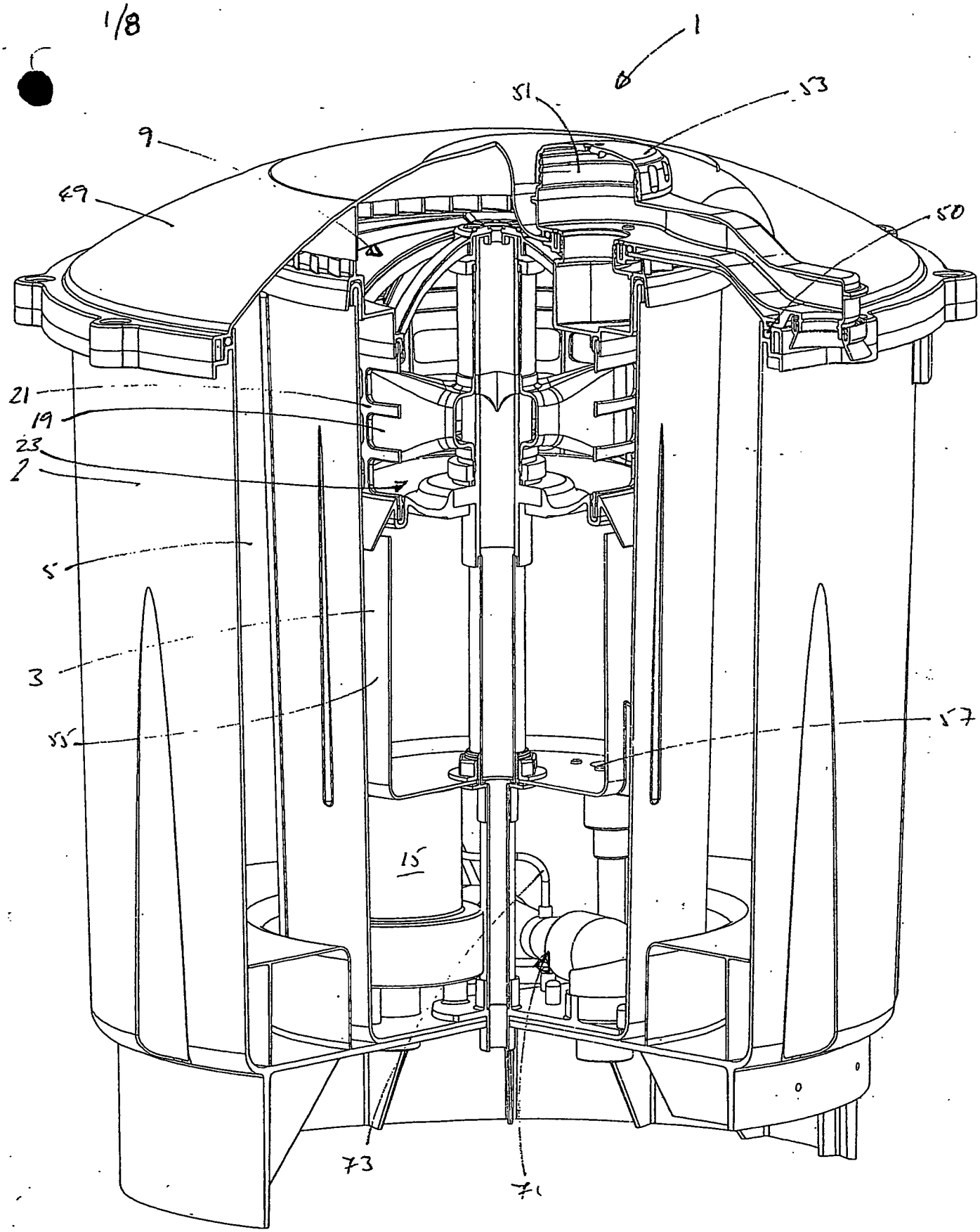


FIG. 1

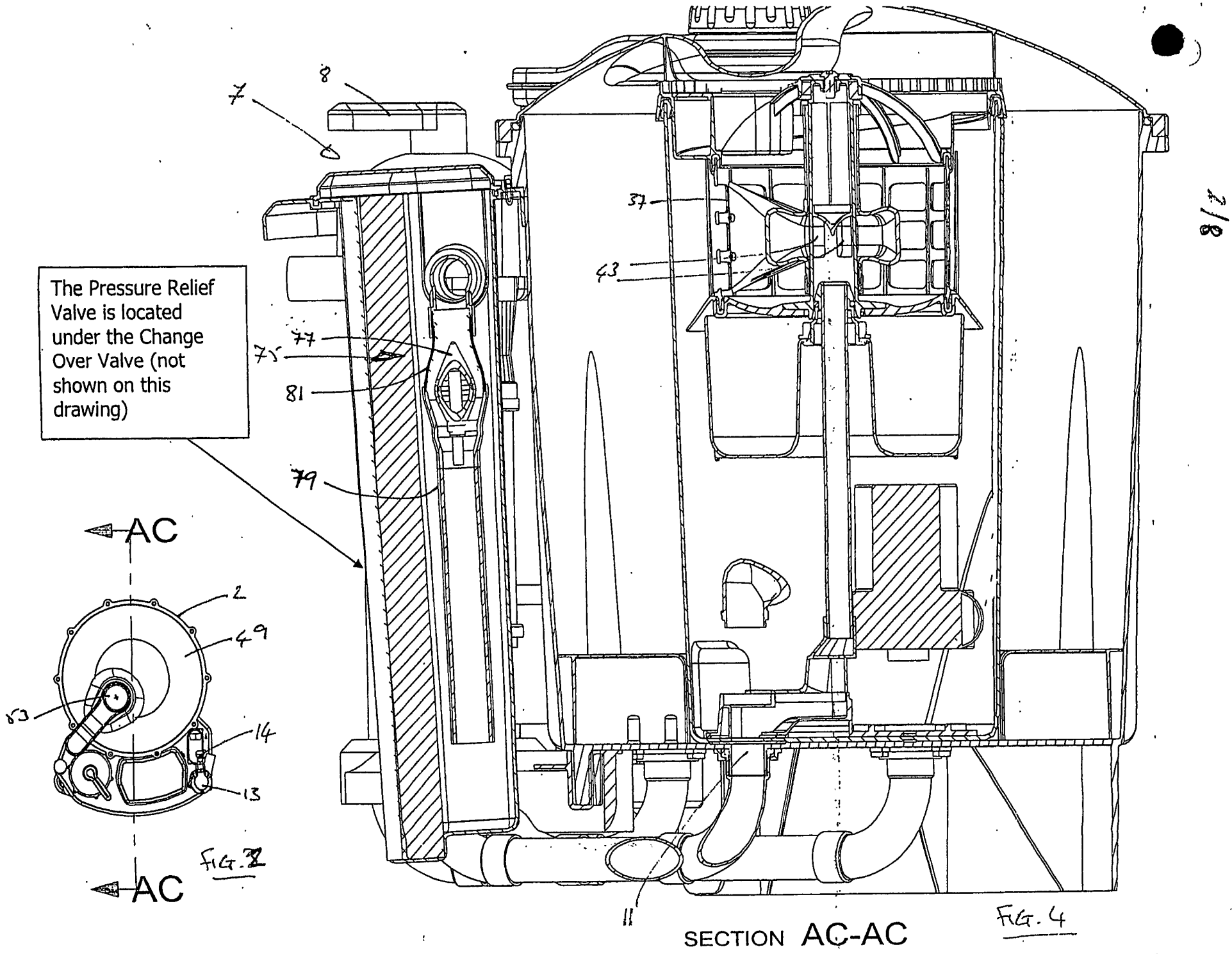


FIG. 3

SECTION AC-AC

FIG. 4

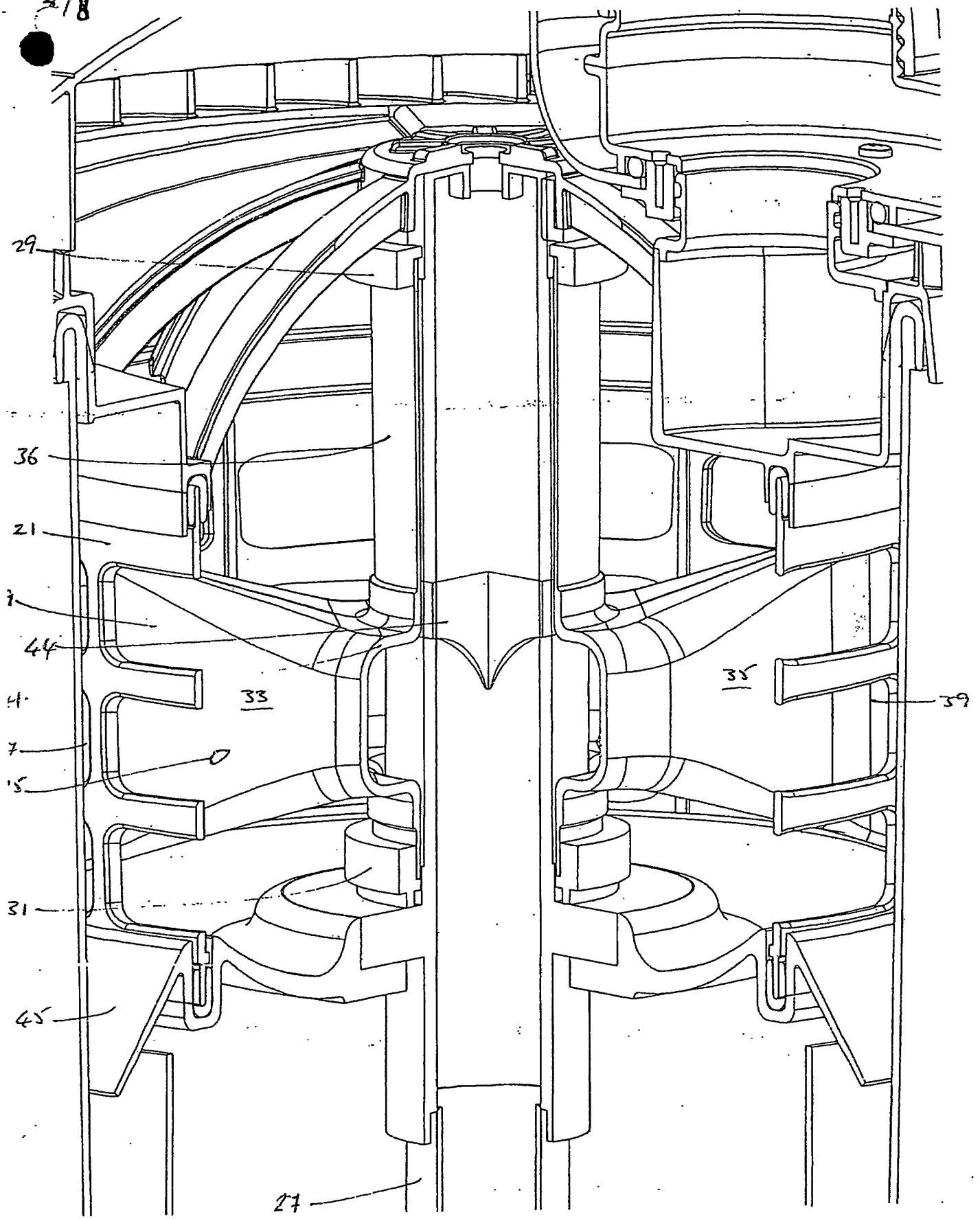


FIG. 3

Here is a section of the Pressure Relief Valve. Please note this is only a test rig

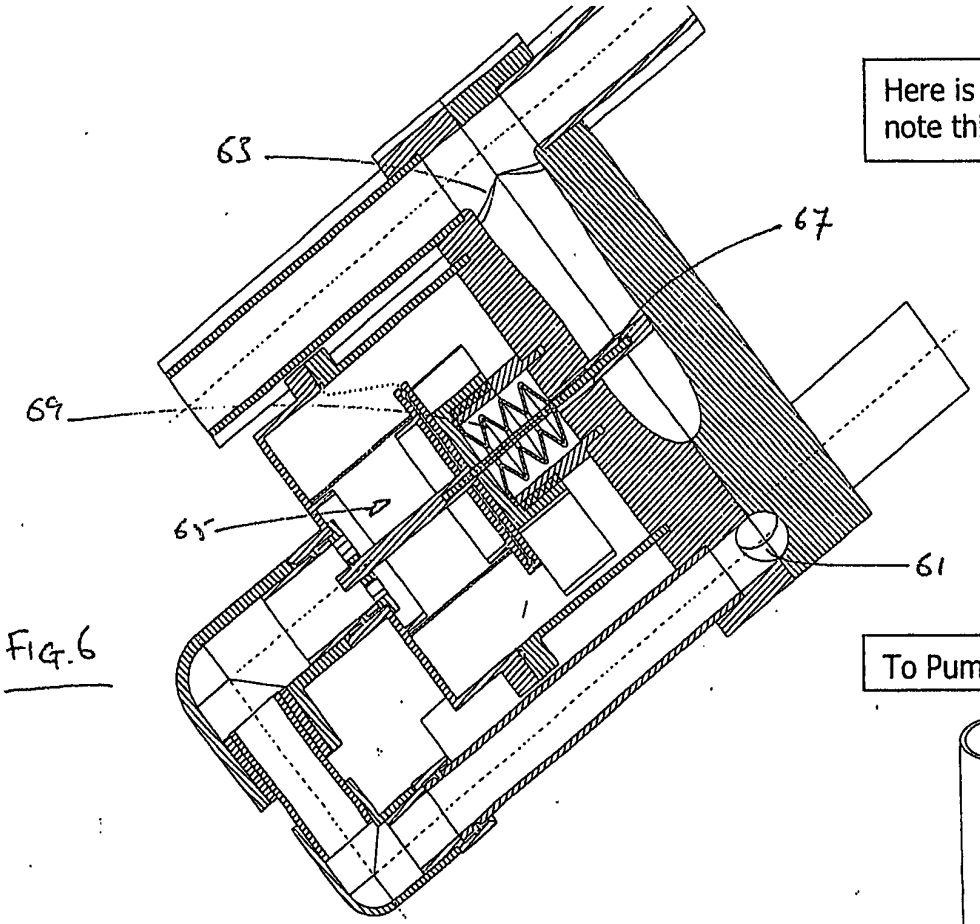
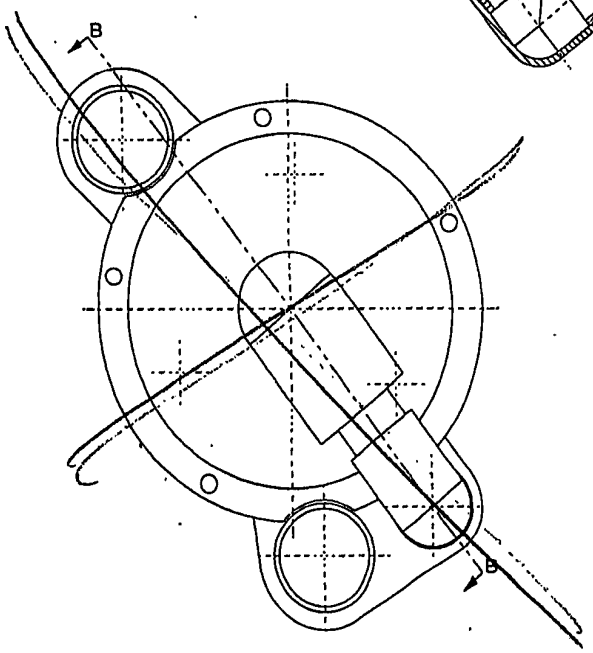


FIG. 6



SECTION B-B

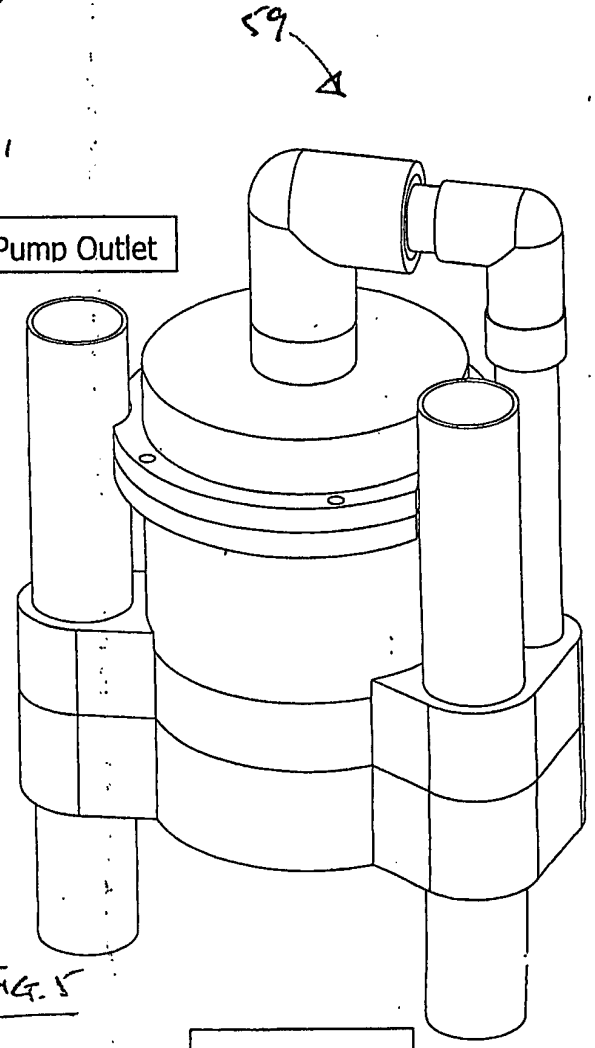


FIG. 5

Normal Operation

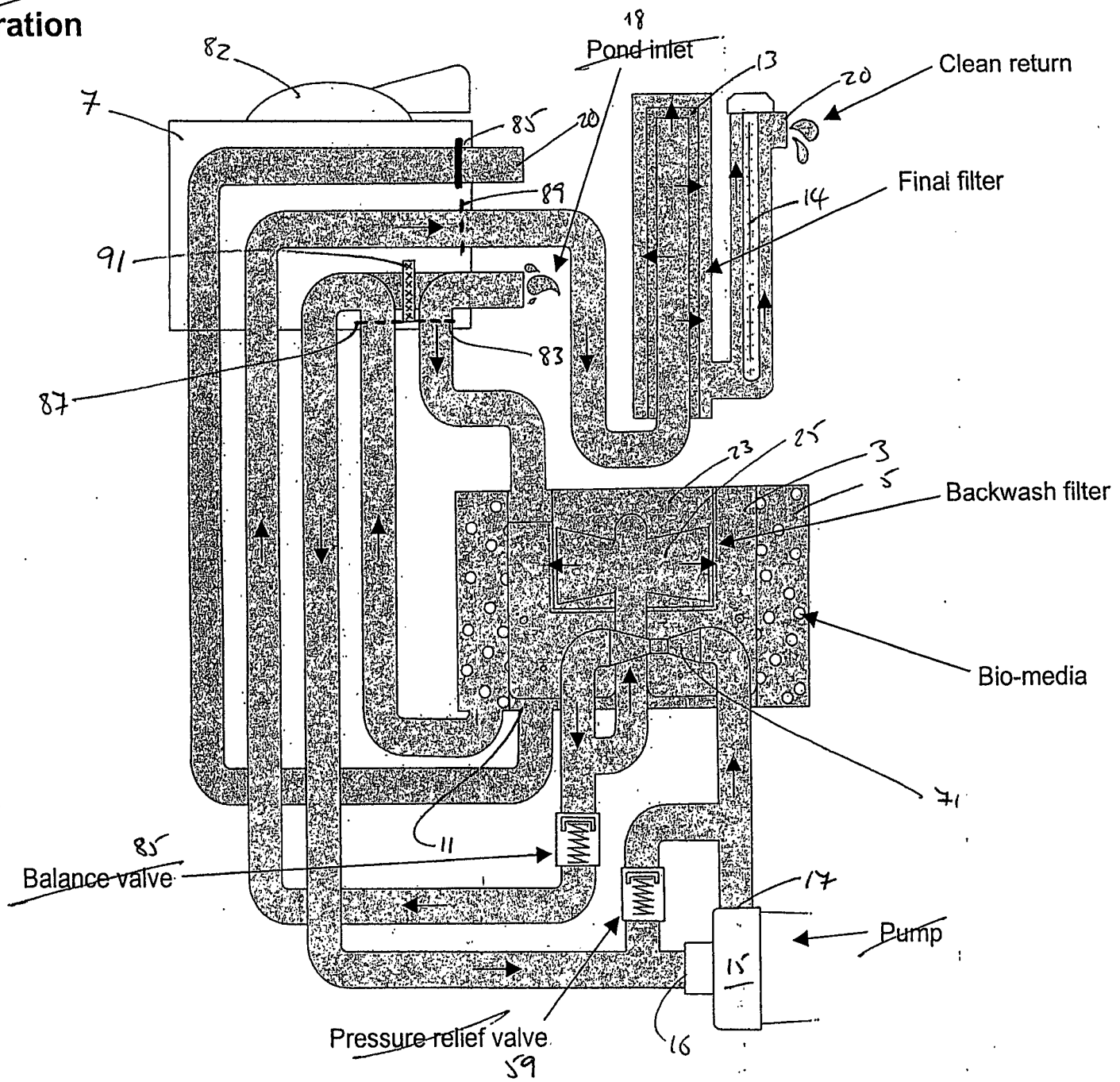


FIG. 7

8/15

Debris Discharge

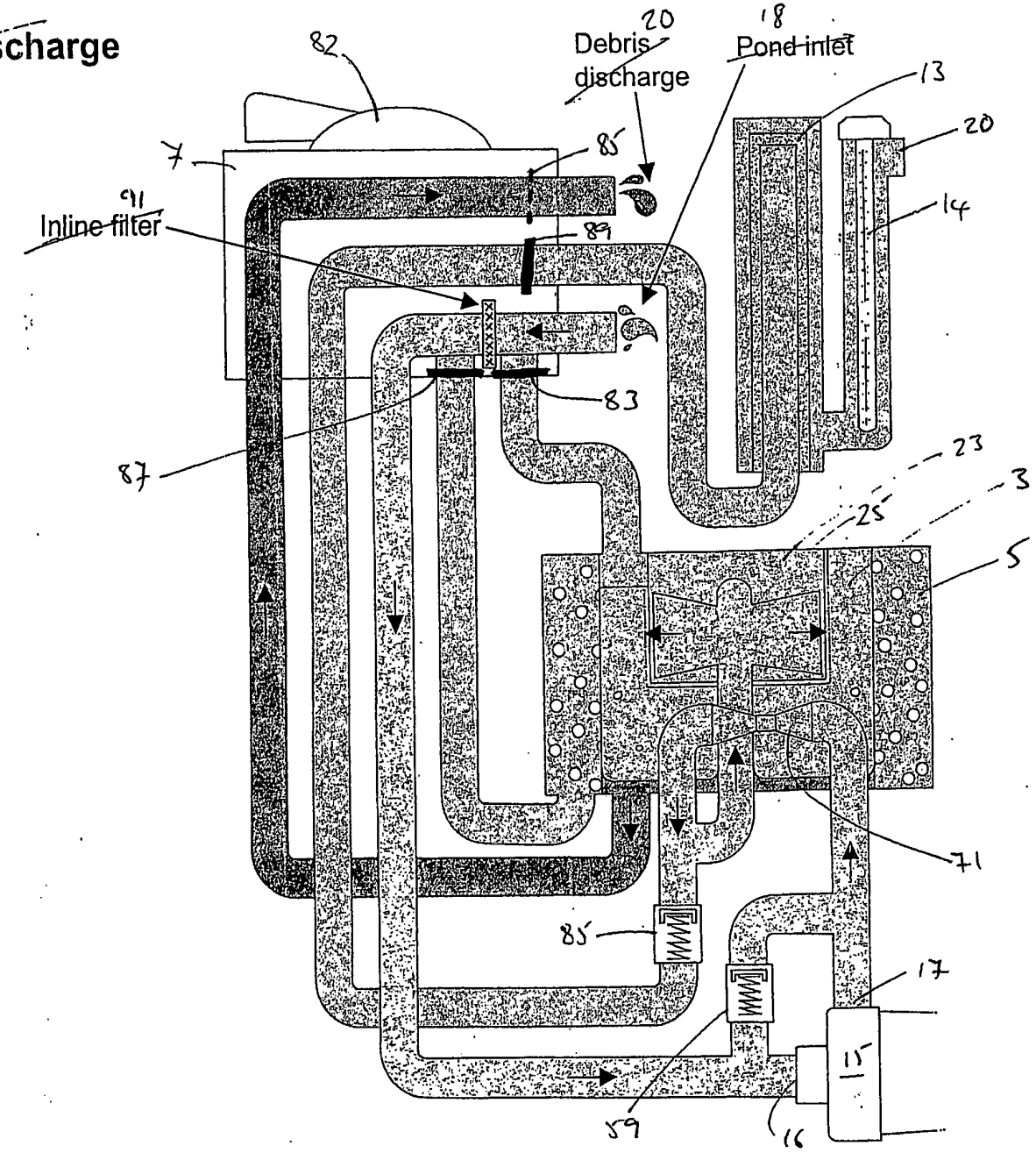


FIG. 8

NORMAL RONNING

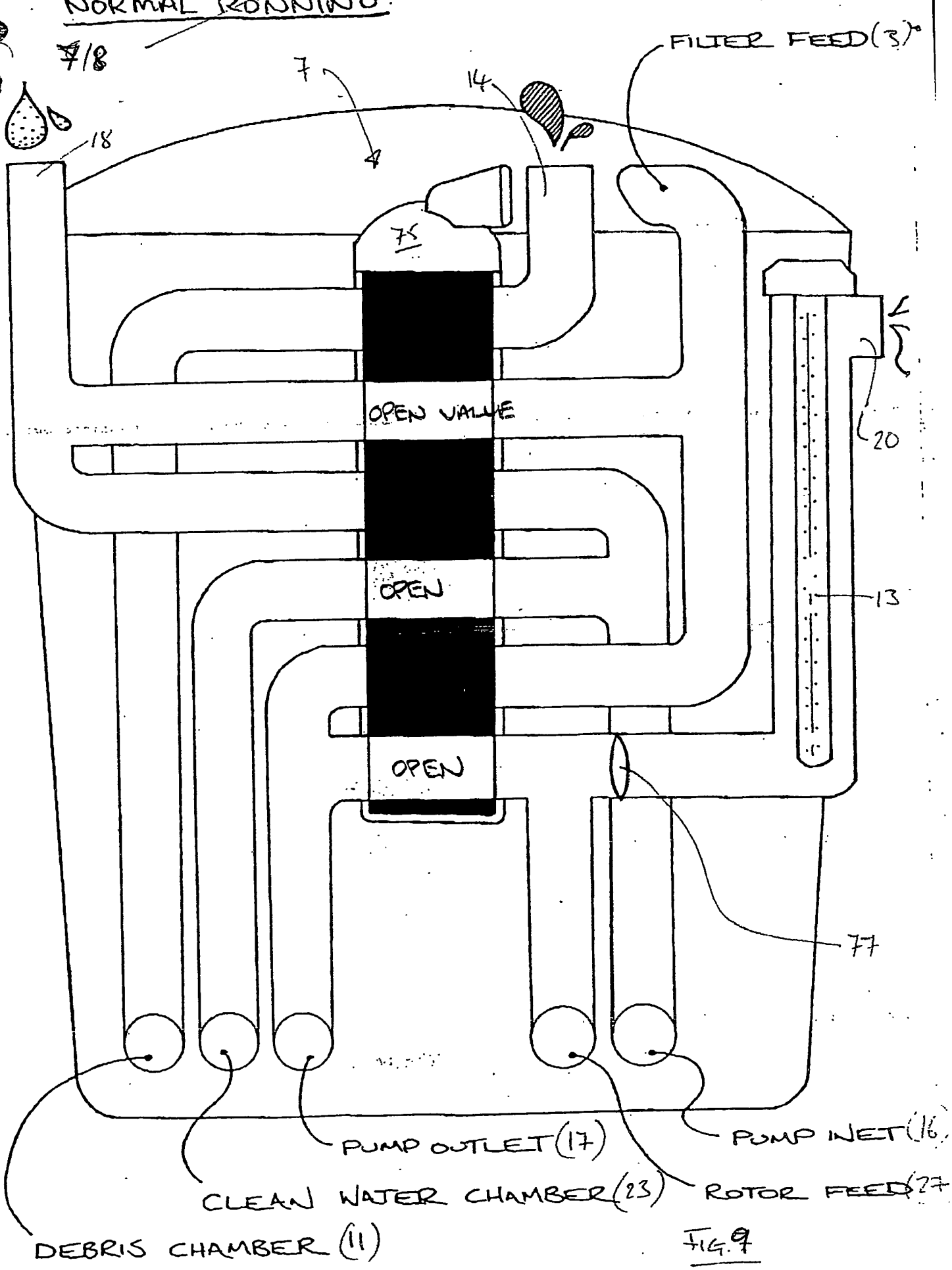


FIG. 9

DESLUDGE

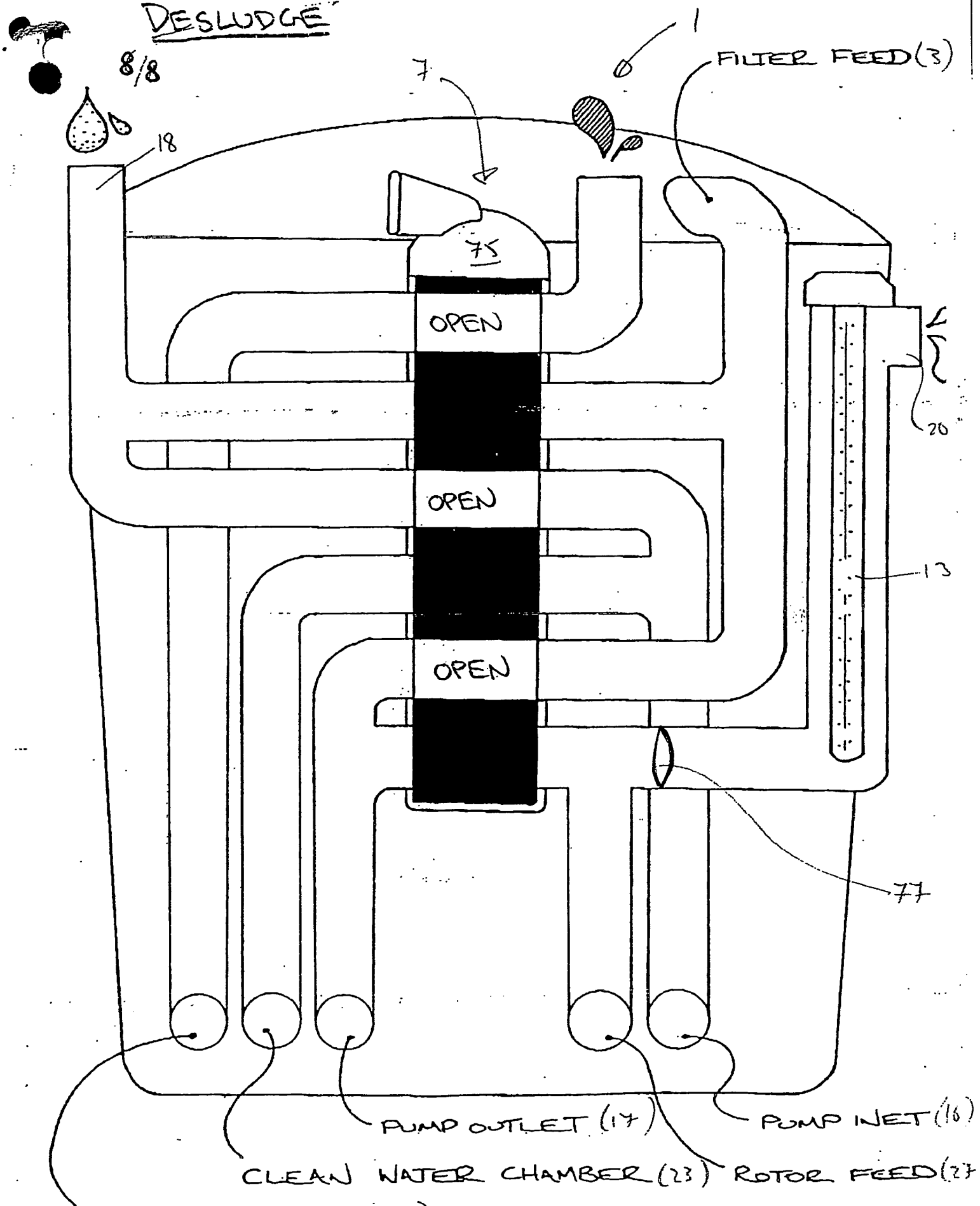


FIG 10